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No 106

ECONOMIC INTELLIGENCE REPORT

MASONRY COMMUNICATIONS TOWERS IN EAST GERMANY: PLANS, PATTERNS, AND PURPOSES 1957-60

CIA/RR ER 60-10
April 1960

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

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CIA-RDP79R01141A001600100001-1

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FOREWORD

Much speculation has arisen in the intelligence community concerning the purposes of about 63 masonry towers that have been under construction in East Germany since 1957. Cursory estimates imply that these towers are associated only with a normal program to enlarge conventional telegraph, telephone, and broadcast services to an extent consonant with economic growth. Nevertheless, the size of the program, the speed of its prosecution, its coverage, and the noneconomic entities of government concerned with the program suggest that political, social, and military considerations also are involved. To the extent permitted by the available information, this report discusses the structure of the towers, their probable applications to conventional and specialized communications, and the economic implications of the program. In addition, this report touches briefly on some of the political, social, and military considerations that may have entered into the construction of the towers.

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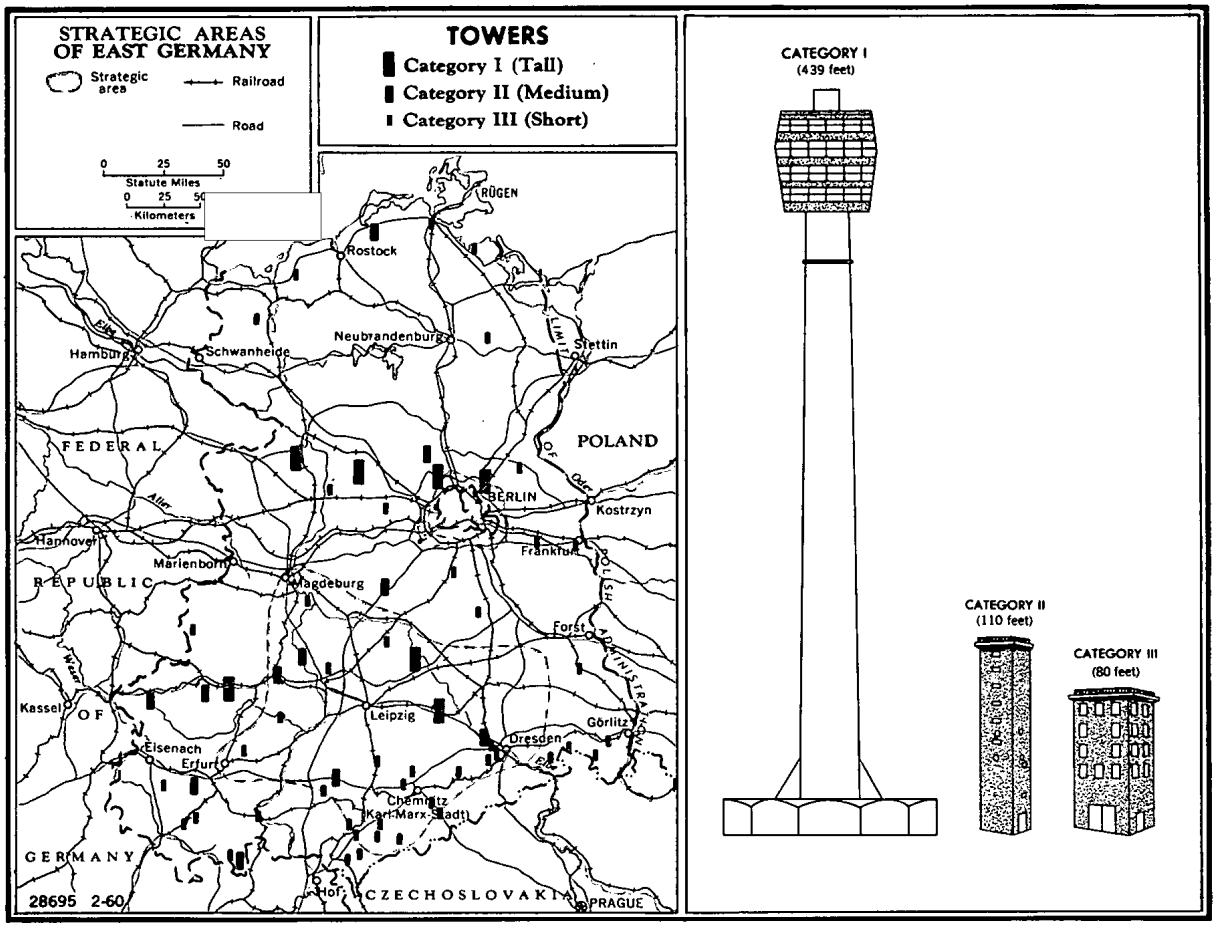
MASONRY COMMUNICATIONS TOWERS IN EAST GERMANY: PLANS, PATTERNS, AND PURPOSES* 1957-60

Summary and Conclusions

Since 1957, masonry towers for housing electronic equipment have been under construction at 63 locations in East Germany. By size and shape these towers fall into three basic categories. The map and the sketch below show the geographic locations and the external structural



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* The estimates and conclusions in this report represent the best judgment of this Office as of 1 February 1960. Technical terms are defined in Appendix A, Glossary of Technical Terms.

features of each category. Of the 63 towers, which represent only a portion of the total number to be constructed, 7 are in Category I (tall), 11 are in Category II (medium), and 45 are in Category III (short).

These towers will contain electronic equipment with which to expand conventional telephone, telegraph, and broadcast services. In addition, at least some of the towers probably will accommodate other electronic equipment for purposes that are not yet clearly revealed. The total cost of constructing these towers, unequipped, is estimated to be 27 million DME.* The total cost of known conventional equipment is estimated to be about 58 million DME.

As users of these towers, the following four parts of the government of East Germany are directly concerned with the program: the Ministry of Post and Telecommunications (Ministerium fuer Post- und Fernmeldewesen -- MPT), the Central Committee of the Socialist Unity (Communist) Party (Sozialistische Einheitspartei Deutschlands -- SED), the Ministry of Defense (Ministerium fuer Nazionale Verteidigung -- MINAVE), and the State Radio Committee (Staatliches Rundfunkkomitee). Some of the towers serve more than one user and for more than one purpose, showing that the over-all tower program has been integrated at high government levels.

The towers will be organized into two groups to enlarge two existing microwave radio relay networks, one of the MPT and the other of the SED. The tall towers will be used in the enlarged MPT network. Employing domestic equipment with a capacity of 600 telephone channels or 1 television channel, this network will include three connected rings -- the northern, middle, and southern -- designed to improve the operational reliability of the public telephone, telegraph, and local and network television services of the MPT. The television service of the State Radio Committee will be greatly improved in quality and coverage, both in East Germany and in West Germany, by the antennas to be placed on these towers.

All of the medium towers and most of the short towers will be used in the enlarged SED network. Employing equipment with a capacity of 8 telephone channels (selected from 20 alternative channels), this network when completed in 1962 would extend the coverage, improve the reliability, and strengthen the physical security of SED communications service.

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* Deutsche Mark East (East German marks). Unless otherwise indicated, DME values in this report are expressed in terms of current DME and for construction costs may be converted to US dollars at the rate of exchange of 4 DME to US $1. For communications equipment costs, DME may be converted to US dollars at the rate of exchange of 9 DME to US $1.

Some of the towers appear to be intended for specialized purposes as well. Speculatively the tall towers could provide services for radar, missile guidance, telemetering, meteorology, or electronic countermeasures (ECM). Some of the short towers may close the southern ring of the microwave radio relay network of the MPT. Other short towers near the border of West Germany probably will be used to jam radio broadcasts from West Germany. All medium and short towers serving the SED probably will be used also by MINAVE in a special air defense network, as part of a long-range program to integrate microwave radio relay facilities with a "hardened" underground coaxial cable line that is already started but is far behind schedule. This over-all system, with probable connections to the USSR and other countries of the Soviet Bloc, would greatly improve the reliability of communications in the Bloc.

The construction of tall towers in East Germany is believed to be related to a program of the Organization for Cooperation Among the Socialist Countries in the Fields of Post and Communications (OSS). The OSS is mainly concerned with standardizing, integrating, and expanding the telecommunications networks of the countries of the Soviet Bloc. To the extent that the program in East Germany is related to OSS objectives, it may foreshadow similar developments in the other countries of the Bloc.

The tower program in East Germany also appears to be part of a broader effort, probably encouraged by the USSR, to achieve greater control of a politically unreliable East German population, to communize both the East German and the West German people, to support the growth of the East German economy, and to improve communications for the East German police and military forces. In this effort the East-West contentions over the status of Berlin and East Germany may have been a factor.

I. Introduction

The masonry towers under construction in East Germany since 1957 are located remote from large population centers. These towers are surrounded by high security fences and guarded by uniformed personnel who live in or near them. The structural form of these towers is plain, and there are no facilities to handle large numbers of visitors. These towers are not, therefore, artistic showpieces but are essentially functional.

The basic function of the towers is to provide elevation for communications purposes. Because the towers are enclosed, a secondary function is to provide protected housing for equipment and personnel. For most applications, functional towers need to be neither masonry nor enclosed. The availability of raw materials, the cost, the environment, and the durability in war, among other considerations, determine the type of construction. The primary emphasis in this report, however, is on the function of the towers rather than on the towers themselves.

II. Physical Characteristics

Since 1957, masonry towers have been under construction at 63 sites in East Germany. These towers are generally located at the highest point in the vicinity of the construction site and are served by good roads. On the basis of their shape and size, the towers can be grouped into three basic categories.

A. Category I (Tall)

Category I towers have been observed under construction at seven locations in East Germany,* and plans indicate that similar structures will be constructed at four other locations. The locations and estimated heights of these towers are given in Table 1.**

The tall towers are circular structures built according to two basic designs. Three of the towers are tapered structures reaching a masonry height of about 439 feet. The remaining four are straight structures of constant diameter, ranging in height from about 197 feet to about 328 feet. Of the four tall towers planned for construction, the two at Glienick and Petkus will be straight, and the two at Dresden and Schwerin will be tapered.

1. Tapered

The photographs and sketches, Figures 1 through 5,*** show the important features of the three tapered tall towers that have been identified to date. Built of reinforced concrete poured in place, each tower has a foundation slab 100 feet in diameter.**** This width is estimated to be sufficient to support the dead weight of the tower and to resist stresses imposed by wind. The tower is windowless and tapers from a base diameter of 35 feet to a diameter of 24 feet at

* See the map, Figure 10, following p. 14.
** Table 1 follows on p. 5.
*** Following p. 4.

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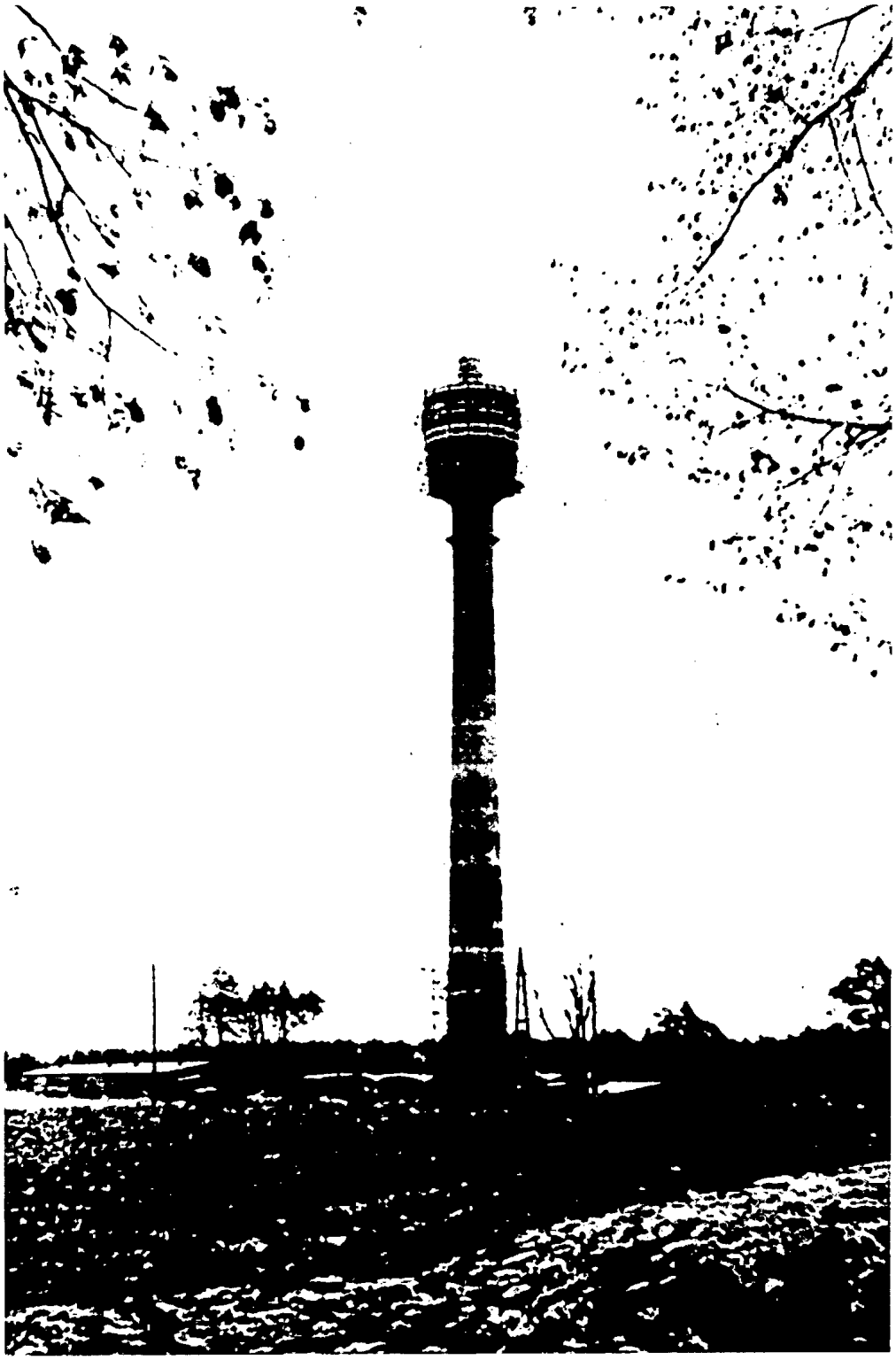
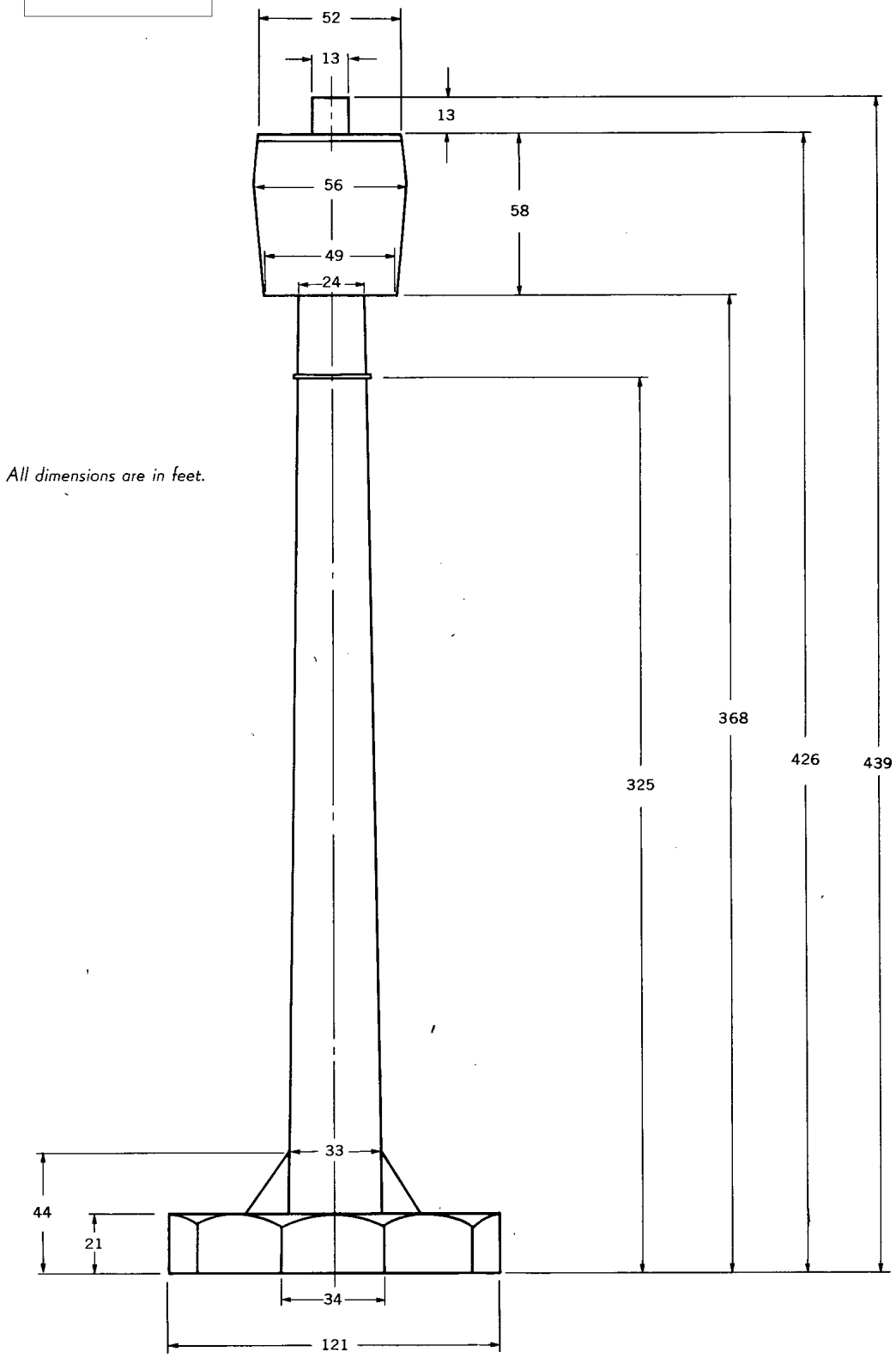


FIGURE 1
East Germany: Tapered Category I (Tall) Tower Under Construction at Perwenitz, 1959

Figure 2

50X1



All dimensions are in feet.

EAST GERMANY: Sketch of Tapered Category I (Tall) Tower Under Construction at Bernau/Birkholz and Perwenitz, 1959

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50X1

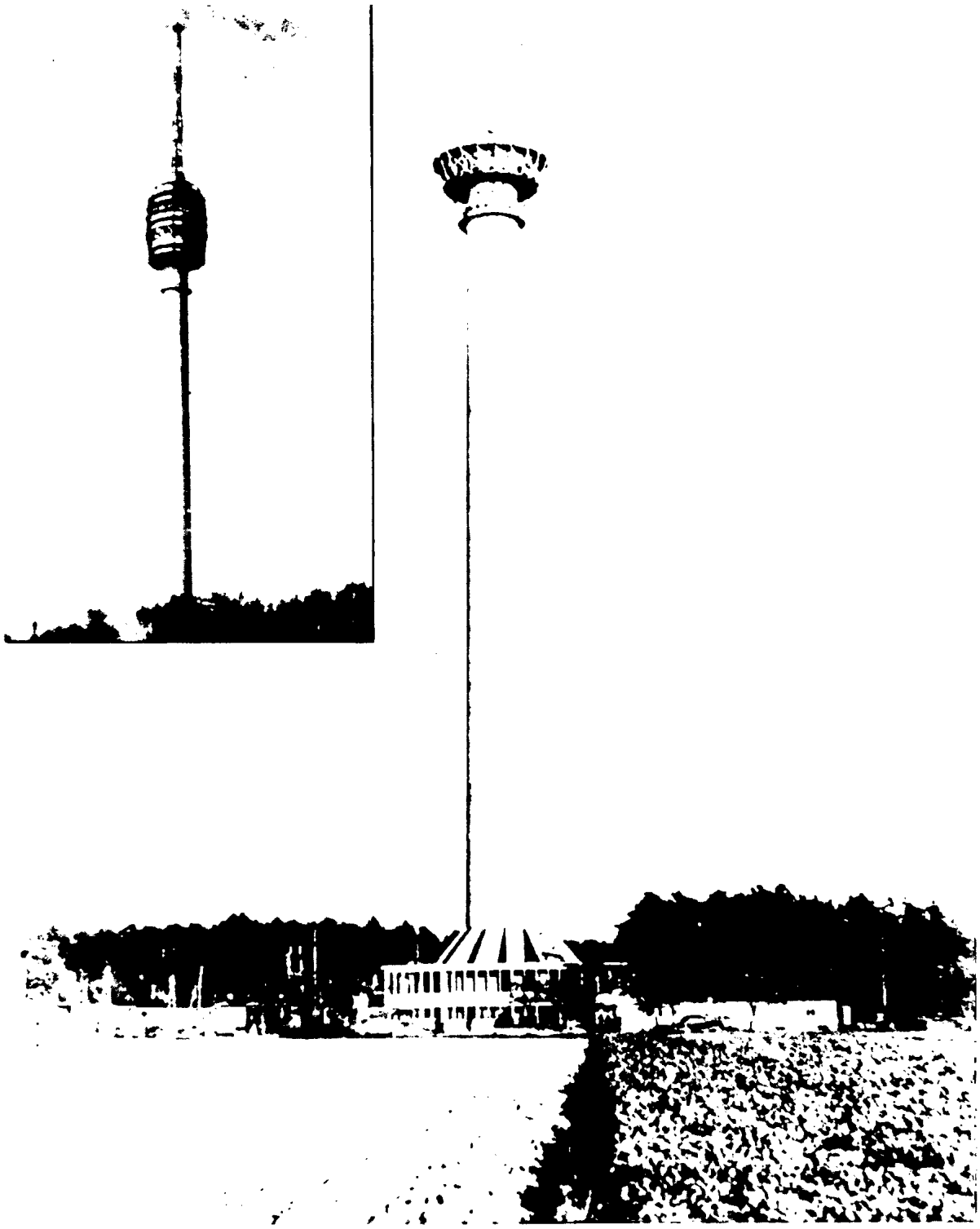


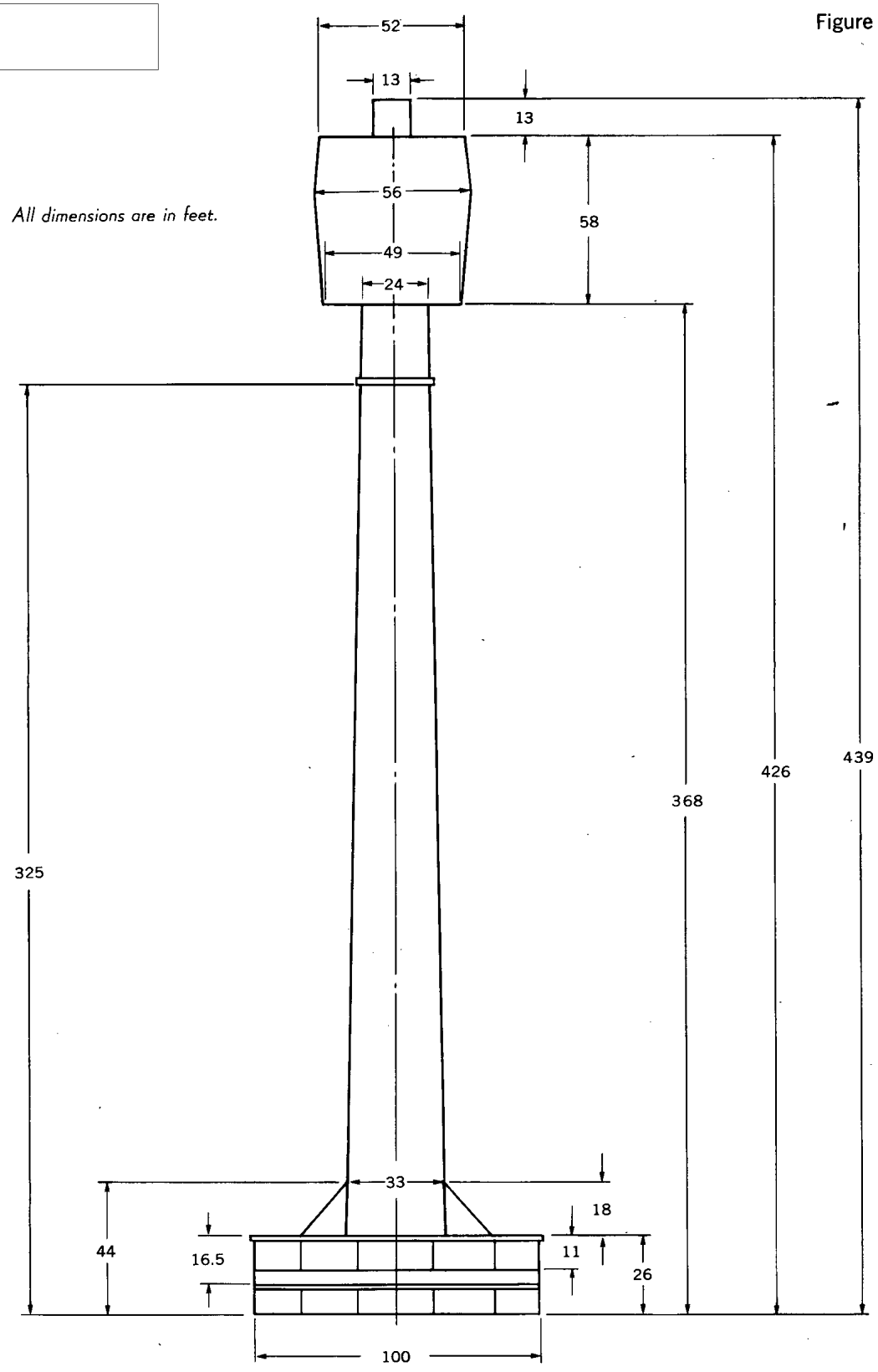
FIGURE 3
East Germany: Tapered Category I (Tall) Tower Under Construction
at Dequede, 1959

50X1

FIGURE 4
East Germany: Base Structure of the Tapered Category I (Tall) Tower Under Construction at Dequede, 1959

Figure 5

50X1



EAST GERMANY: Sketch of Tapered Category I (Tall) Tower Under Construction at Dequede, 1959

28704 2-60

50X1

Table 1

Location and Estimated Height of Category I (Tall) Towers in East Germany 1959

Name of Nearest Town		Estimated Height (Feet)	50X1
	Tapered Towers		
Bernau/Birkholz		439	50X1
Dequede		439	
Perwenitz		439	
Dresden (planned)		439	
Schwerin (planned)		N.A.	
	Straight Towers		
Kulpen-Berg		328	50X1
Oschatz		197	
Rhinow		275	
Roitzsch		275	
Glienick (planned)		262	
Petkus (planned)		220	

the 354-foot level. As the tower rises, the thickness of the walls is reduced. At the top of the tapered column (354 feet) is a five-story circular structure 58 feet high. The diameter of this structure, 56 feet at the widest point, probably is dictated more by space requirements than by strength requirements. In this upper-level structure are about 7,300 square feet of enclosed usable floorspace. The floors and ceiling of the four-story circular structure probably are supported by about 15 precast concrete joists that radiate out from and are supported by an elevator column which runs up the center of the tower. In addition to housing the elevator mechanism, this column provides a base for the antenna that is to be mounted at the top of the tower.

There are minor differences between the tapered tower at Dequede and the towers at Bernau/Birkholz and Perwenitz. As shown in the photographs, Figure 3* and Figure 4,* and the sketch, Figure 5,*

* Following p. 4, above.

the base structure of the Dequede tower is two stories high with a concrete roof sloping in toward the tower. The base structures of towers at Bernau/Birkholz and Perwenitz, however, are only one-story high and have curved, thin-shell concrete roofs. The towers at Bernau/Birkholz and Perwenitz are completely encompassed by the base structure, but the tower at Dequede is not. Nevertheless, both types of base structure probably contain the same amount of enclosed floorspace, about 10,000 square feet.

Construction costs of the tapered towers are not known but can be estimated on the basis of these physical characteristics and of inputs of material and manpower. On this basis the cost of each tower, without equipment, should approximate 1.5 million DME. 1/*

2. Straight

The photograph, Figure 6,** shows the straight tall tower during construction at Rhinow. All straight tall towers under construction or planned are similar to this one. Like the tapered tall tower, the straight tall tower is built of reinforced concrete poured in place. The floors at each level are poured as integral parts of the tower as the walls reach each level. One basic form is used; it is raised after each floor has set. At the top of the straight column is a one-story glass-enclosed structure. As shown in the photograph, Figure 6, the tower at Rhinow has windows for light and ventilation at the six lower levels and the five upper levels. The lower levels probably will serve as living areas and the upper levels as working areas. 2/

On the basis of these physical characteristics, it is estimated that the tower at Rhinow, unequipped, will cost about 1 million DME. Because construction costs do not vary in direct proportion to height, this figure is not representative of the cost of other straight tall towers. Probably the total cost of constructing these towers will not exceed 4 million DME.

B. Category II (Medium)

Category II towers have been observed in various stages of construction at 11 locations in East Germany.*** The locations of the towers sighted to date are given in Table 2.****

50X1

** Following p. 6.
*** See the map, Figure 12, following p. 20.
**** Table 2 follows on p. 7.

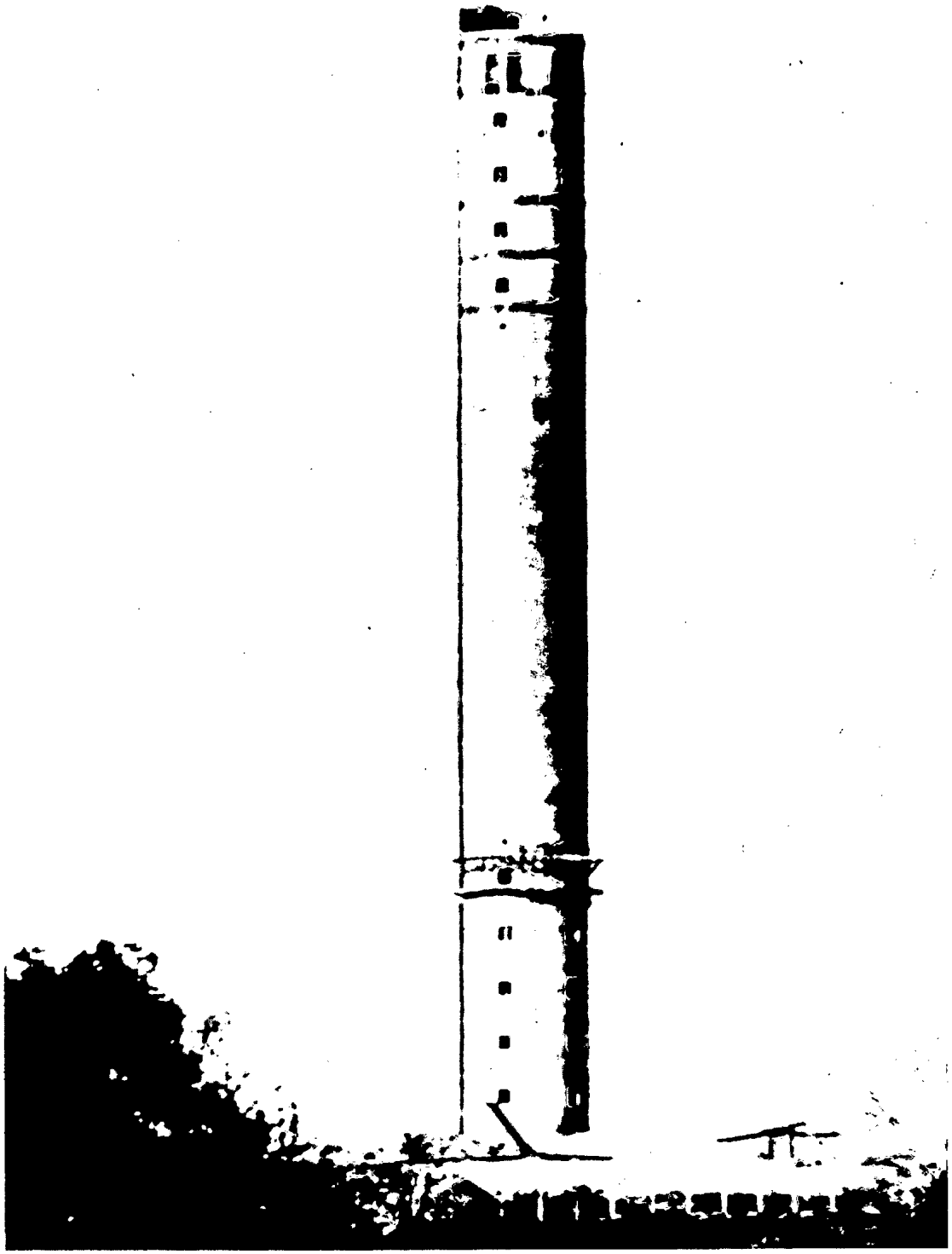


FIGURE 6
East Germany: Straight Category I (Tall) Tower Under Construction at Rhinow, 1959

Table 2

Location of Category II (Medium) Towers
in East Germany a/
1959

Name of Nearest Town
Blankenheim
Dingelstadt
Gera
Gresenhorst
Langenburg
Polenz
Raben
Sandersleben
Sondershausen
Sonneberg
Wolfslake

50X1

a. All Category II (medium) towers are 110 feet high.

These medium towers are identical and probably have been built from standard plans. The towers are relatively slender, flat-roofed structures, 14 feet square and 110 feet high. The photograph, Figure 7,* and the sketch, Figure 8,* show the important features of these towers.

The medium towers have been built using both concrete cast in place and precast construction techniques, separately or in combination. At one site, for example, two sides of the tower were cast in place, and the other two sides were precast in sections equal to the height between floors and were lifted into place. At another site the four walls and floor of each level are believed to have been cast at the same time, a technique in line with the construction time of 2 to 3 months reported for some of these towers.

The walls of the medium tower are thicker at the base than at the top, but the tower has no exterior taper. No evidence of a basement has been noted in any of the towers. In addition to a staircase rising from the ground floor to the roof, there probably is a center opening in each floor for vertical movement of equipment.

* Following p. 8.

The medium towers have about 12 levels, each about 8 feet high. Built of concrete, the floors of each level are about 9 inches thick. The available floorspace is adequate for equipment but not for living quarters. The flat, overhanging roof is surrounded by an iron railing, and anchorage points at the four corners indicate that the roof will serve as a mounting platform for an antenna. All medium towers are surrounded by a fence, which may house some type of warning device against intruders. It is possible that the medium towers will be unattended. This possibility is suggested by the limited space within the towers as well as by the apparent mounting of warning equipment for the detection of intruders on the fence surrounding the towers.

On the basis of analogy and known characteristics, the estimated cost of each tower, unequipped, should be about 146,000 DME. 3/

C. Category III (Short)

Category III towers have been observed in various stages of construction at 45 sites in East Germany.* These towers are located primarily along the mountainous southern border of the country and, except for two of 100 feet each, range in height from 50 to 80 feet. This wide range in the heights of the short towers probably is related to elevation and terrain conditions at or near the site as well as to the purposes for which the particular tower is being built. The locations and estimated heights of the short towers sighted to date are given in Table 3.**

The size, shape, and window arrangement of the short towers vary, but the basic design is quite uniform, suggesting a basic standard design that was altered only slightly to fit conditions of construction and use. The sketch, Figure 9,*** shows the typical features of a short tower.

Built of stuccoed brick, the typical tower is a 5-story, flat-roofed structure 27 feet long, 18 feet wide, and 80 feet high. The floors and roof are constructed of reinforced concrete. There are two entrances to the tower, one of which is wide enough to accommodate a loaded truck. Some of the towers have a basement about 14 feet deep. Foundations for three pieces of mechanical or electrical equipment are cast on the basement floor, and a ventilation shaft is provided on the outside of the basement wall.

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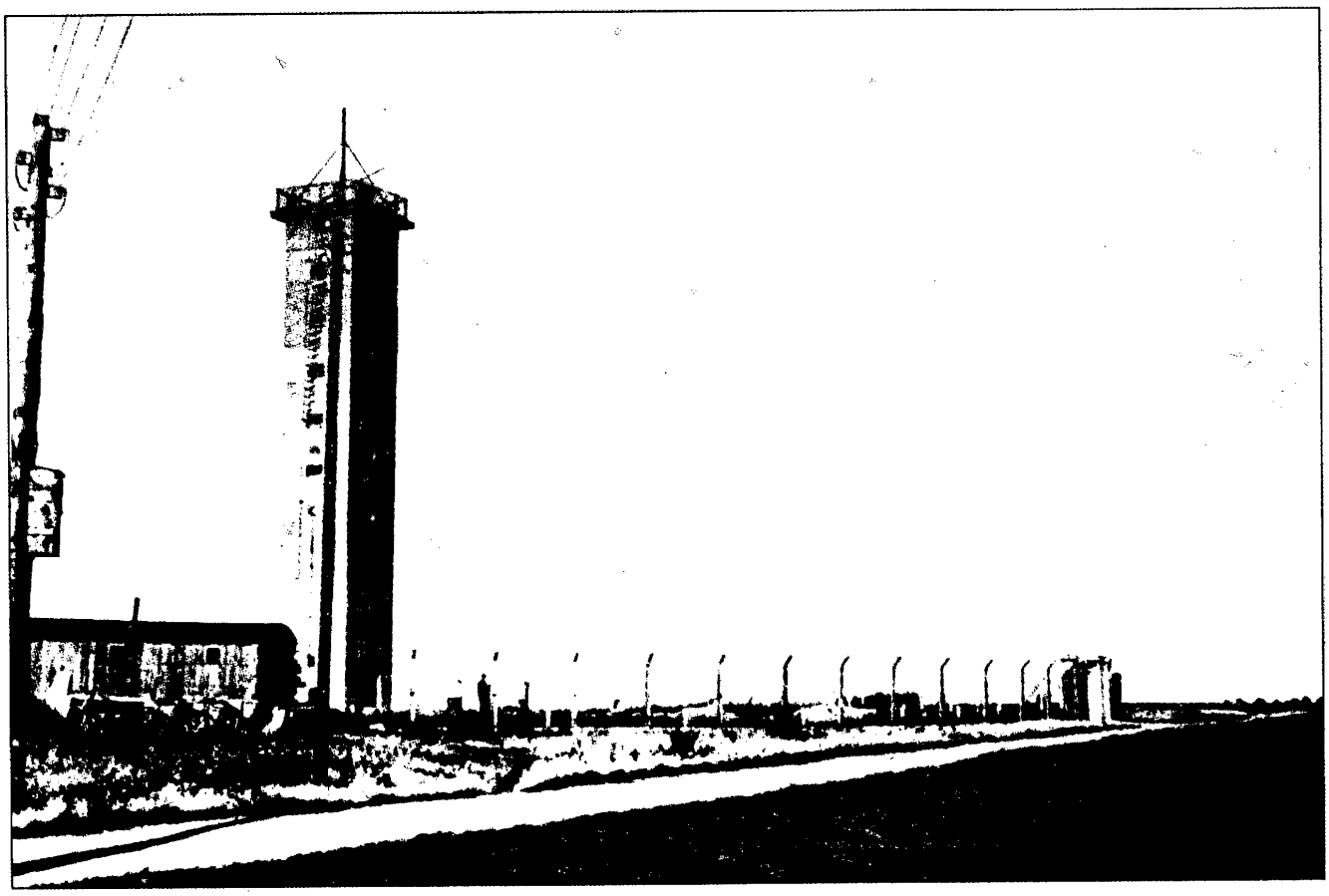
* See the map, Figure 12, following p. 20.

** Table 3 follows on p. 9.

*** Following p. 8.



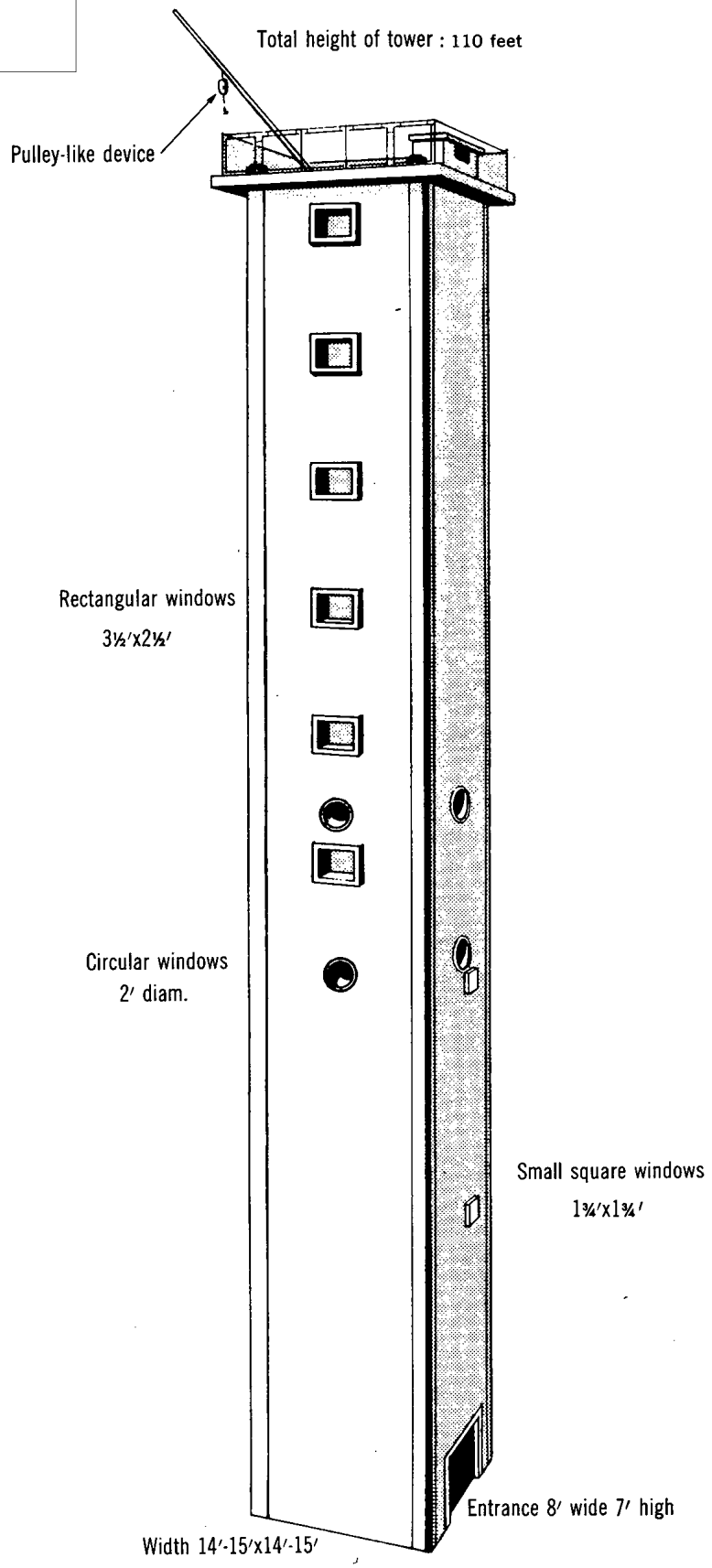
50X1

50X1

FIGURE 7
East Germany: Category II (Medium) Tower Under Construction at Sandersleben, 1959

50X1

Figure 8



EAST GERMANY: Sketch of a Completed Category II (Medium) Tower

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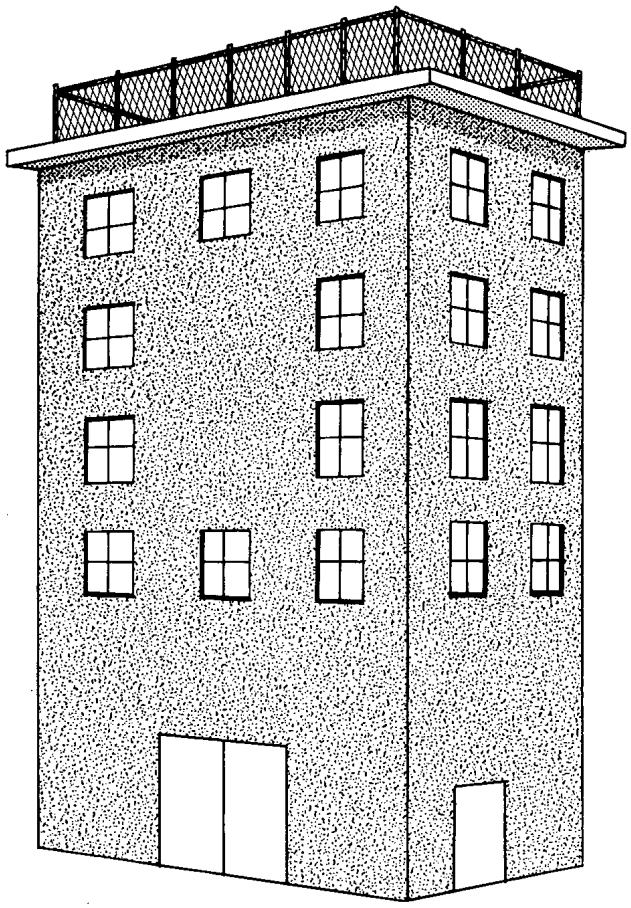
50X1

[redacted]

Figure 9

50X1

Total height of tower : 80 feet



EAST GERMANY: Sketch of a Typical Category III (Short) Tower

28706 2-60

[redacted]

50X1

Table 3

Location and Estimated Height of Category III (Short) Towers in East Germany 1959

50X1

Name of Nearest Town	Estimated Height (Feet)
Altenburg	50
Bad Freienwald	80
Bernsbach	70
Bless-Berg	60
Brocken	50
Brotterode	80
Buchenwald	70
Burgstadt	80
Dahme	50
Dolgowitz	80
Freiberg	60
Gottmansforde	60
Greiz	80
Heineberg	60
Hohendorf	80
Kesselsdorf	50
Kietz	50
Kleinbocka	60
Kottmar	70
Limbach	50
Loissin	90
Marienberg	70
Matzdorf	50
Netzschkau	80
Olesnitz	80
Pesterwitz	60
Peters-Berg	80
Picho	80
Planitz	60
Radis	60
Rauen	80
Rosengarten	80
Saalfeld	80
Schneekopf	80

Table 3

Location and Estimated Height of Category III (Short) Towers
in East Germany
1959
(Continued)

Name of Nearest Town	[redacted]	Estimated Height (Feet)
Schoenebeck		70
Spremberg		50
Stralsund		100
Suhl		80
Trebbin		60
Unger		66
Voigtsgruen		60
Wakendorf		80
Wangener		100
Werda		80
Wurgwitz		80

50X1

The first floor of the short tower serves as a garage and utility center. With the exception of the top floor, the remaining floors are used for living quarters and office space. The top floor is used to house communications equipment and possibly other electronic equipment. In the centers of each floor and of the roof are openings about 3 feet by 5 feet. These openings provide a clear access from the roof to any floor in the tower and facilitate the raising or lowering of equipment.

An iron fence surrounds the roof of the short tower. Steel tie-down plates are embedded in concrete at the four corners of the roof. [redacted] a steel mast about 98 feet high and weighing about 12 tons will be mounted on the roofs of these towers. Such masts, mounting parabolic antennas, have been observed on at least two of the towers.

50X1

The area within about 1,000 feet of the tower is posted as a prohibited zone. In addition, a 7-foot mesh wire fence has been constructed about 100 feet from the tower. Supported by concrete posts, this fence encircles the tower. At the fence a transformer station, about 9 feet square and about 25 feet high, also has been constructed.

The cost of construction of individual short towers will vary with the height of each structure. On the basis of the information available on inputs of materials and manpower, the cost of construction of the presently identified short towers, unequipped, is estimated to be about 17.2 million DME. 4/

III. Purposes of the Towers

The masonry towers under construction in East Germany are functional structures. It is clear that one of the purposes of these towers is to house and support equipment for use in expanding conventional telecommunications services -- telephone, telegraph, and broadcasting, but they also could accommodate electronic equipment for other specialized purposes. For conventional services the towers will house equipment for new or expanded microwave radio relay networks, and some of the towers also will support antennas for radiobroadcasting and telecasting.

At present, there are two major microwave radio relay networks in East Germany. One is operated and controlled by the Ministry of Post and Telecommunications (MPT) and the other by the Central Committee of the Socialist Unity (Communist) Party (SED). The MPT network is used to carry public telephone and telegraph traffic. Facilities of the network also serve as the primary medium for relaying television programs within East Germany, connecting all television stations with the main studios in East Berlin. The MPT microwave network was set up in 1951, when a 28-kilometer (km) line was installed between Nauen and Berlin to be used exclusively for telephone service. In late 1952 a 13-km line connecting the television studio in Berlin/Adlershof with the television transmitter at the Stadthaus in East Berlin was put into operation. After the installation of this line, facilities of the MPT network were expanded significantly and by the end of 1958 consisted of about 1,300 km of line. 5/

The SED network is a relatively secure multichannel microwave radio relay system used almost entirely to carry telephone and telegraph traffic of the Communist Party. Originally the network was controlled by the Ministry of the Interior but was operated by the Garrisoned Peoples Police. Shortly after the network was constructed, however, operation and control passed to the SED. The transfer was intended to give exclusive use of the facility to the SED, but the Garrisoned Peoples Police and possibly its successor, the East German Army, continued to use the network.

The SED microwave network was begun in 1953 in direct consequence of the uprising of 17 June 1953. During the uprising the wireline network of the Secretary for State Security of the Ministry of the Interior

was almost completely disrupted, partly by sabotage, thus lessening the ability of internal security forces to contain the uprising. This incident pointed up most sharply to the SED the acute need for alternative facilities to give more flexible and reliable telecommunications service. For this purpose the East German government decided to install a microwave radio relay network. Construction by the technicians from the Sachsenwerk-Radeberg plant began in late 1953. By the end of 1956, facilities of the network consisted of about 27 terminal and relay stations with about 1,350 km of line. 6/

Operation of the MPT and SED microwave radio relay networks has not reached full efficiency. The most important reasons are excessive distances between some terminal and relay stations, resulting in the transmission of weak signals over many important routes; use of low-capacity, obsolete equipment, resulting in a limited service capability; and use of long lead-in high-frequency cables, which cause high losses of power between the equipment and the antennas and result in the transmission of weak and distorted signals. These shortcomings reveal not only hasty and somewhat poor engineering design but also the inability of the electronics industry of the country to develop and produce better equipment. 7/

In consequence of these shortcomings, East Germany has embarked on a two-phase program to modernize, reorganize, and expand these two networks. The first phase, underway since 1957, calls for the construction of masonry towers. Entailed in this phase is the replacement of all existing temporary steel microwave towers with concrete or brick installations and the construction of additional microwave terminal and relay stations. The second phase of the program consists of installing in all these new towers high-capacity microwave equipment employing up-to-date technology. 8/ These towers also might accommodate equipment for such services as command and control of guided missiles, radar for air defense, electronic countermeasures, and tactical communications. Although inconclusive, the available information strongly suggests that at least some of these towers will be used for these services.

A. Category I (Tall)

The MPT in East Germany embarked in 1957 on a program to modernize, reorganize, and expand its microwave radio relay and television networks. The major goals of the program were to establish a long haul, high-capacity microwave radio relay network capable of meeting the increased demands for speedy and reliable telephone and telegraph service and to extend the domestic coverage and improve the technical quality of radio and television broadcasting. Scheduled for completion in late 1964 or early 1965, the program entails constructing massive concrete towers for microwave radio relay

communications and television broadcasting purposes, replacing existing temporary steel microwave towers with concrete or brick installations, constructing additional television and radio relay stations, installing modern microwave radio relay equipment in all towers, and increasing the power of television transmitters currently in use.

Category I towers are a part of that program. As shown on the map, Figure 10,* such towers are under construction at seven sites. Four more towers are planned, and construction of these towers should begin during 1960-61. The geographic distribution of the tall towers, built and planned, shows the pattern of the future development of the microwave radio relay network and therefore of the television network. With these structures serving as the major terminal and relay facilities, the network will extend both east and west and north and south. It will consist of three major connected rings -- the northern, the middle, and the southern -- and traffic will be able to flow over alternate routes should any part of the network become inoperable.

The towers at Dequede, Rhinow, Perwenitz, Bernau/Birkholz, and Roitzsch probably will be put into operation in mid-1960. Construction of these facilities is nearly completed, and the installation of equipment should begin shortly. Plans indicate that these towers will contain modern microwave radio relay and television equipment for telephone and telegraph communications and for broadcasting. In addition, the towers at Dequede and Perwenitz and probably the one at Bernau/Birkholz will contain equipment for FM (frequency-modulation) broadcasting and for radio-telephone and radio-telegraph communications other than microwave radio relay.

The microwave radio relay equipment to be used will be the type RVG-958, which is being developed by the Rafena Plant in East Germany. A prototype should be available by early 1960, and full-scale production should begin in 1961. The RVG-958 operates on 4,000 megacycles and can provide either 600 telephone channels or 1 television channel. On this basis it is assumed that at least two pieces of RVG-958 equipment would be installed in each tower to provide 600 two-way telephone channels and 2 television channels, 1 in each direction. The television transmitters that are to be used will have a power of 10 kilowatts (kw). Produced by Koepenick Radio Plant, also in East Germany, this equipment should be available in early 1960. In addition, more than 2 million DME have been allocated for the import of two 10-kw television transmitters from West Germany. At present, research is being conducted for the development of high-gain television antennas for use in conjunction with transmitters produced in East Germany. Until such antennas become available,

* Following p. 14.

television antennas imported from the West German firm of Rhode and Schwarz will be used. 9/

All communications equipment will be housed on floors or platforms located near the top of the towers, as shown in the photograph, Figure 11.* The microwave radio relay and television equipment will be located close to their antennas, so that the high-frequency cable connecting the equipment and antennas will be shortened, thus reducing losses of power. 10/

Careful and detailed planning appears to have gone into the design and the construction of the tall towers. The towers at Dequede, Rhinow, Perwenitz, and Bernau/Birkholz, however, are higher than would normally be adequate for microwave radio relay transmission. These towers are on relatively flat terrain, about 25 to 30 statute miles apart. For the distances and the terrain involved, towers of from 210 to 260 feet would appear to be adequate, but these towers are about 439 feet high, except the tower of Rhinow, which is about 275 feet high. It is likely, therefore, that the towers were constructed at these heights to extend the range of television broadcasts emanating from the multielement antennas erected on top of these towers.

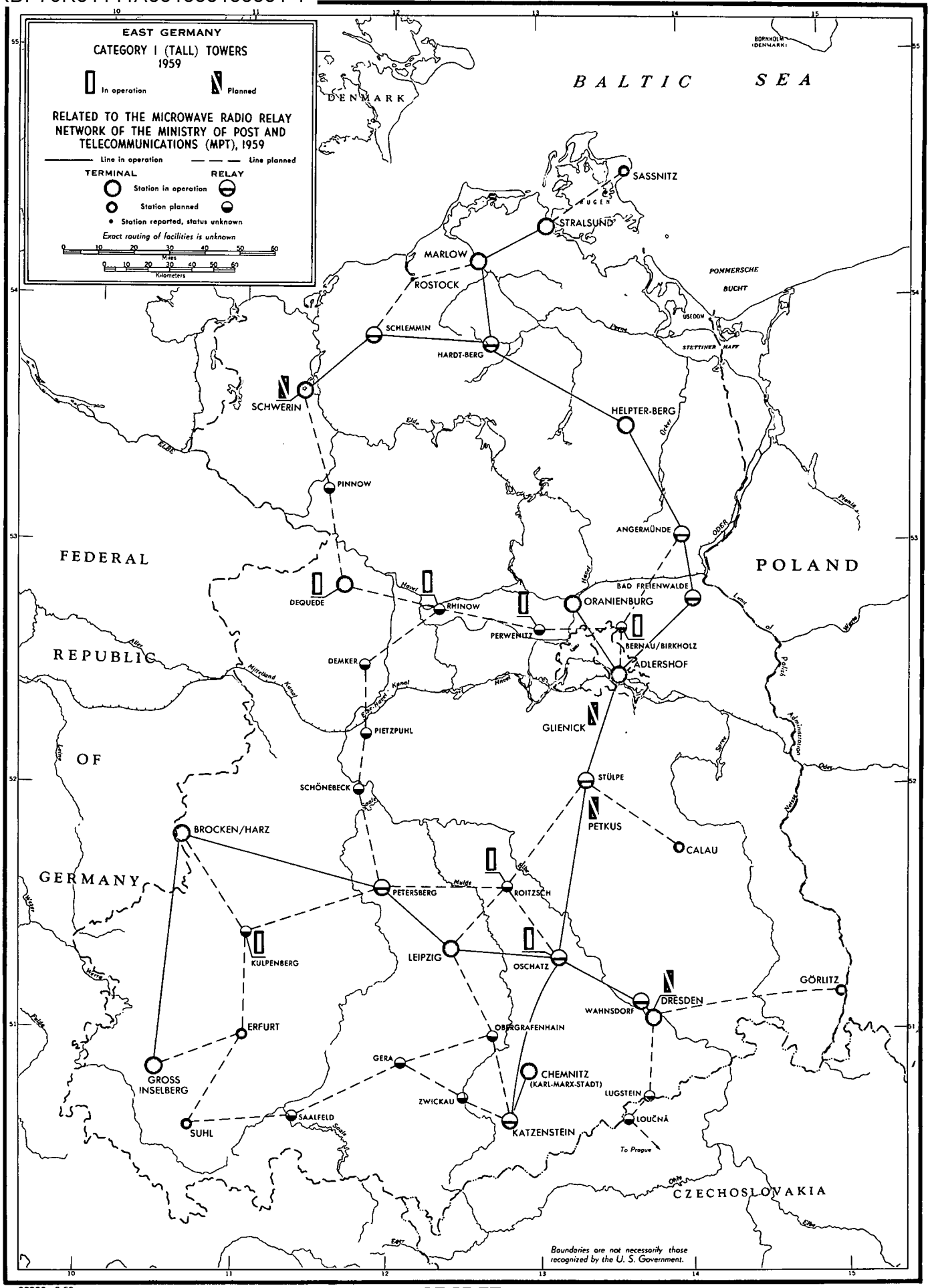
Detailed data on investment for the construction of tall towers and their contents are lacking. [redacted] capital outlays will total about 26 million DME. For the known uses of these towers, this figure is estimated to be reasonable and within the capabilities of the economy. 11/ Nevertheless, the willingness of the East German government to undertake a program of this magnitude does suggest that important political and military considerations were involved in the decision. 50X1

1. Political

Because of its geographic proximity to the West, East Germany is continually exposed to the political and sociological influences of the West. This exposure has led to the heightening of the ideological struggle between East and West Germany. The startling postwar recovery of West Germany, as evidenced by a prosperous West Berlin -- a Western-influenced society in the midst of a Communist-controlled society -- has had an unstabilizing effect on the East German population. The political unrest in East Germany, which culminated in the uprising of 17 June 1953 and which currently results in the defection of more than 1,000 people each month, can be attributed in large part to these influences.

* Following p. 14.

Figure 10



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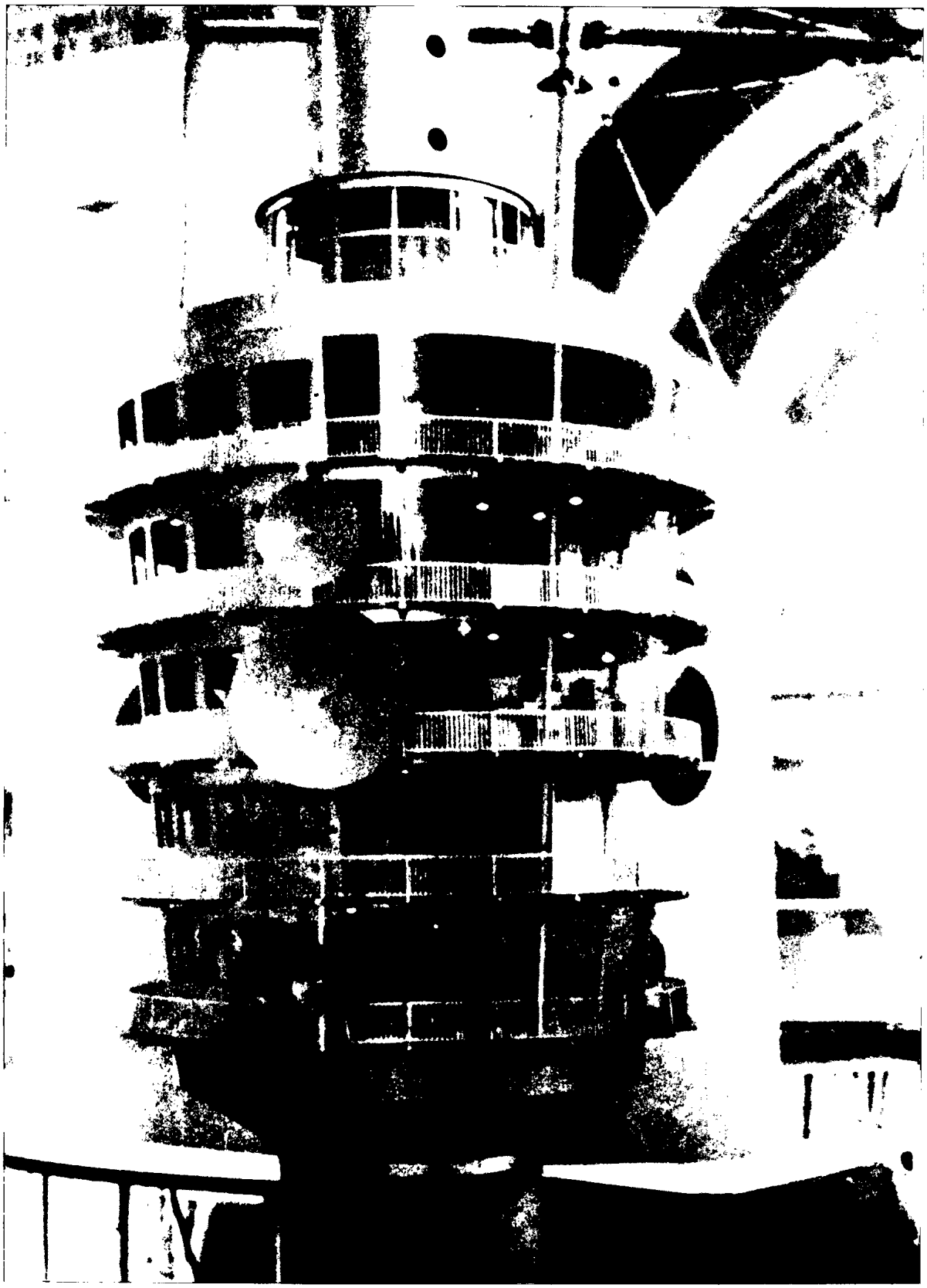

FIGURE 11
East Germany: Model of Microwave Radio Relay Equipment Displayed at Leipzig, March 1959

In this ideological struggle between East and West Germany, media of mass communication such as radiobroadcasting and telecasting have become increasingly important weapons.* Since 1957 the governments of both countries have placed increasing reliance on television, perhaps the most effective of all mass media of communications, in their efforts to capture the minds of the people on the other side. As part of its campaign, West Germany in 1957 began installing new television stations along the East German border. These stations, as well as the large station in West Berlin, extended the coverage of West German telecasts into the heart of East Germany. Complaints appearing in the East German press about citizens who view West German television and then suffer from erroneous impressions "that workers are better off in the West" testified to the effectiveness of these telecasts. In 1959, West Germany announced plans to erect a new television station in West Berlin. One of the major purposes ascribed to this new facility was to bring more East German viewers within the range of West German telecasts. 12/

In response to the buildup of West German efforts at penetration by television, East Germany countered with a penetration program of its own, designed not only to expand and improve telecasts to West Germany and West Berlin but also to minimize the ability of West German telecasts to penetrate East Germany. Steps taken to expand and improve services to West Germany and West Berlin included converting East German television from the standards of the Soviet Bloc to those of Western Europe, installing additional transmitters and increasing the power of existing transmitters along the border of West Germany, and redirecting programing efforts toward cultural presentations rather than propaganda. In an obvious attempt to counter the propagandistic efforts of West German television, East German authorities established a new television transmission frequency and then ordered the modification of all television sets in use in the country. The modification consisted of installing special adapters on the sets, which then would be able to receive only the new frequency. An additional adjustment, paid for by the set owner, was necessary in order for the set to receive the West German transmission frequency. 13/

It is not unreasonable, therefore, to assume that political interests were associated with the East German decision to undertake the program for the construction of tall towers. Completion of this program will extend significantly the reception radius of the East German television network. In addition to providing television service to more than 80 percent of the country, telecasts emanating from these

* The East German State Radio Committee, directly subordinate to the Council of Ministers, is responsible for all broadcasting programs and schedules of East Germany.

facilities will penetrate far into West Germany. It is estimated, for example, that telecasts from the new tower at Dequede will reach as far as the Ruhr. Furthermore, the over-all completion of this program coupled with the completion of the program for increasing the power of the transmitters at Inselberg, Brocken, and Schwerin will enable television programs originating in the main studios in East Berlin to reach audiences in major West German cities such as Hamburg, Hannover, Kassel, and Frankfurt am Main. Because of the high quality of East German programing and the subtlety of its propaganda, these telecasts, in the absence of effective West German countermeasures, could have a telling effect on West German audiences. 14/

2. Military

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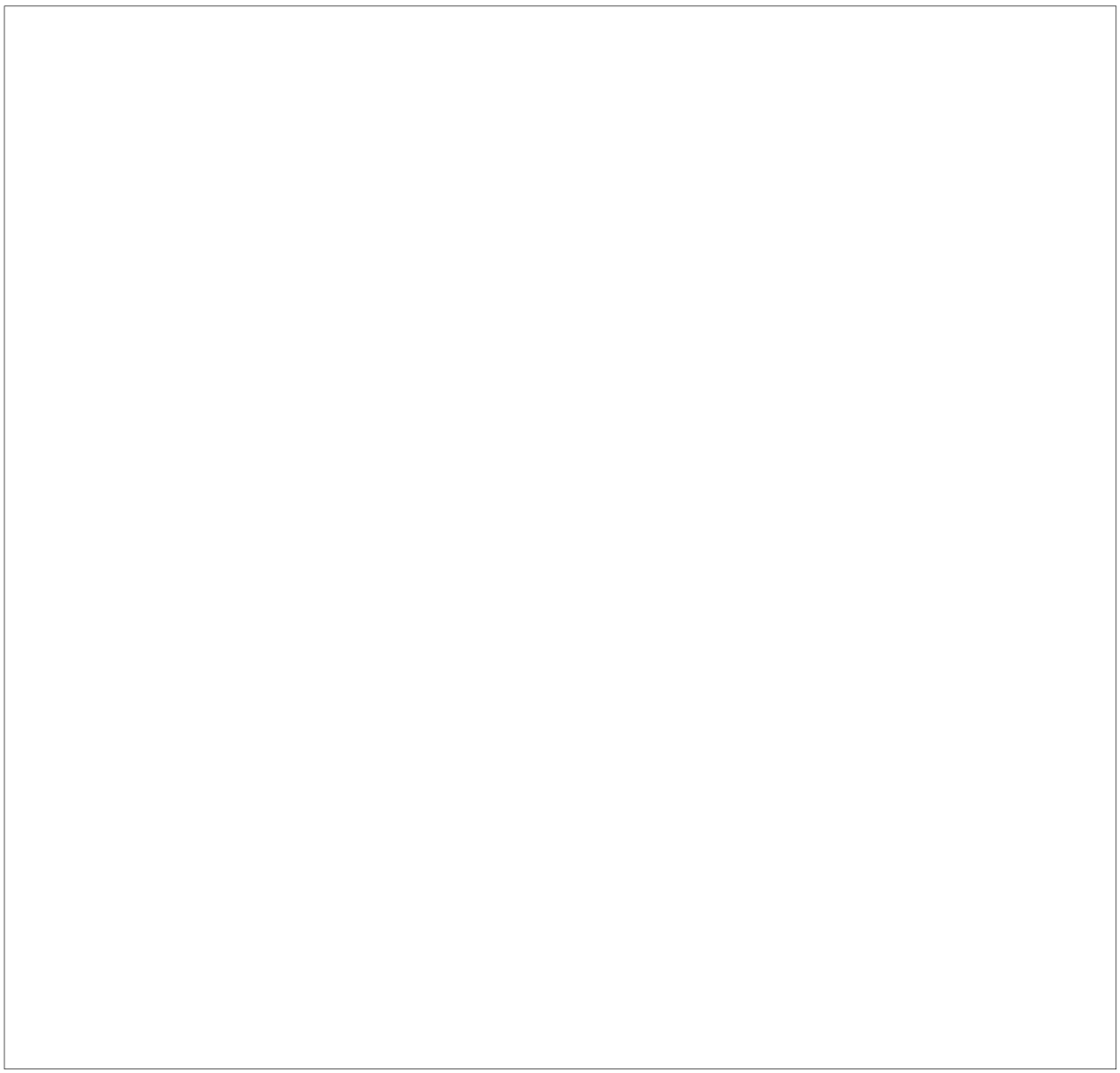

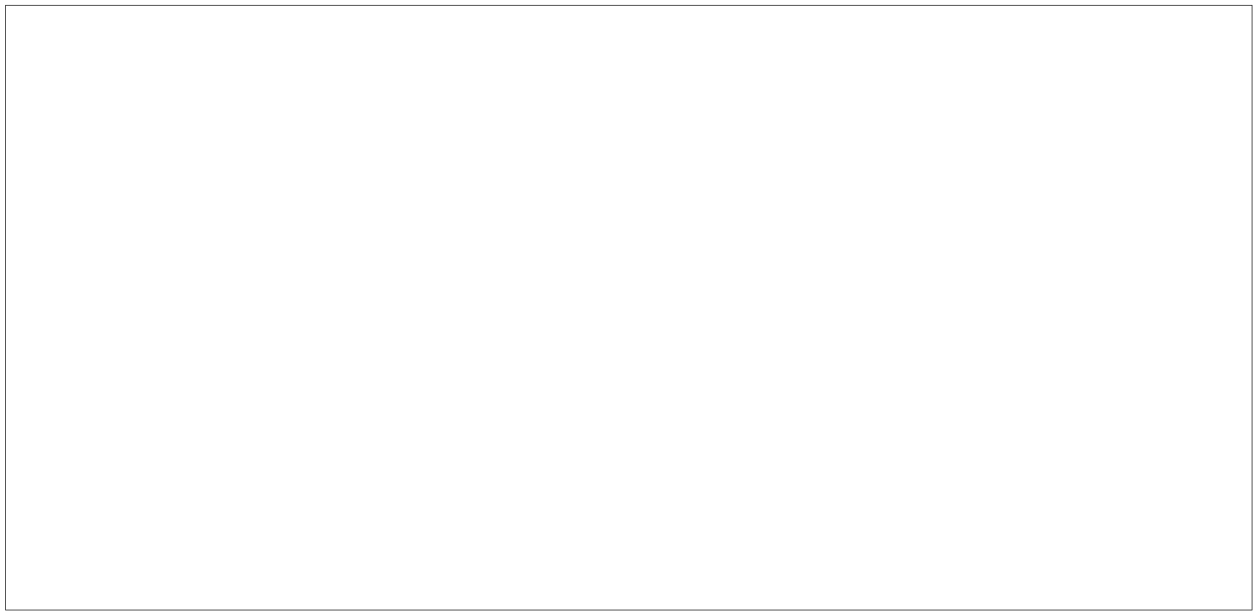

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B. Category II (Medium)

The microwave radio relay network of the SED in East Germany is a relatively secure system used to carry Party telephone and telegraph traffic. This network, which was installed after the uprising of 17 June 1953, connects SED headquarters in East Berlin with subordinate offices in the 14 Bezirke (districts) in East Germany. By this means, effective nationwide control and direction of SED activities is maintained. As early as 1957 the SED initiated plans to improve the facilities of this network in order to overcome operational deficiencies. Evidence suggests that these plans also included the expansion of the network to provide direct communications with subordinate offices located in the 215 Kreise (counties) of East Germany. Such communications would increase the ability of the SED to direct and control activities at the lowest level of government. Expansion and improvement were to be achieved by replacing existing lattice steel towers with concrete or brick structures, by constructing additional microwave terminal and relay stations, and by installing modern equipment in all towers.

The construction of Category II towers in East Germany is part of the planned expansion and improvement of the microwave radio relay network of the SED. These medium towers, together with a large number of smaller, Category III towers,* will become part of the major permanent facilities of a new and expanded microwave radio relay system of the SED.

* A discussion of Category III towers follows in C, below.

The construction of medium towers is completed or nearing completion at 11 identified sites. It is suspected that similar structures are being built at other sites, but it is not yet possible to make positive identification. As shown on the map, Figure 12,* many of the identified towers are collocated with or in close proximity to towers of the existing network. Where new towers do not adhere to this pattern, it is likely that the facility was located so as to shorten path lengths between terminal and relay stations or to further the planned extension of the network.

Medium towers will utilize type RVG-934 and type RVG-924 microwave radio relay equipment. Both types of equipment are being produced by the Rafena Plant, and delivery probably began by the end of 1959. On delivery the equipment will be housed close to the antennas located at the top of the structure. The RVG-934 operates in the range of 2,450 to 2,700 megacycles and is 24-channel equipment. The RVG-924** operates at about 2,600 megacycles and is 8-channel equipment. Because the demand for communications is the heavier at the district level, the greater capacity of the RVG-934 suggests that this equipment probably will be used for district communications and the RVG-924 for county communications. 18/

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* Following p. 20.

** A more detailed discussion of the characteristics of the RVG-924 equipment follows in C, below.

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[redacted] 50X1

C. Category III (Short)

The construction of Category III towers in East Germany also is related to the planned expansion and improvement of the microwave radio relay network of the SED. At the present time, construction of these short towers is completed or nearing completion at 45 identified sites. Similar structures are under construction or planned in other areas of the country, but identification is not yet possible. As shown on the map, Figure 12,* identified short towers are concentrated mainly in the mountainous region near the southern border of the country. These towers are collocated with or are close to other towers of the SED network. When they are not close to other towers, the location may have been fixed by the need for shorter path lengths between stations or by the planned extension of the network.

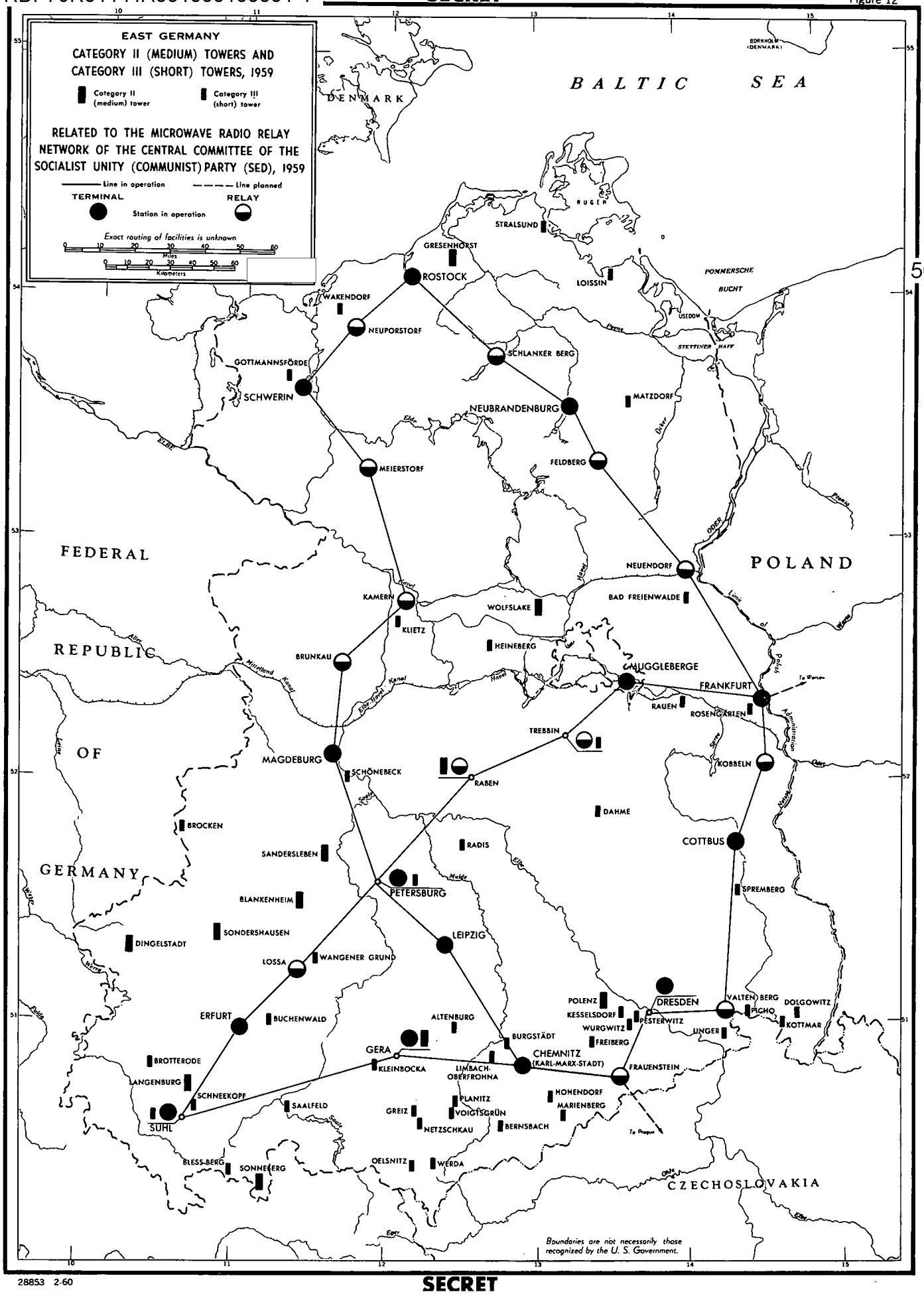
Short towers will utilize RVG-924 microwave radio relay equipment. The use of this equipment, which also is used by the medium towers, is supporting evidence that these towers in combination will form the major fixed facilities of the expanded microwave radio relay network of the SED. Operating at about 2,600 megacycles, the RVG-924 equipment is crystal-controlled and provides 20 alternative voice channels, of which 8 may be used at any one time. The equipment has a standby protective channel with provision for switchover on failure. In addition, receiving units installed at terminal stations can interrogate as many as seven intermediate relay stations. 21/

RVG-924 equipment is being produced exclusively by the Rafena Plant, and deliveries probably began by the end of 1959. Plans for production of this equipment specify peak output during 1960-62 and direct a drastic curtailment of production after 1962.** During 1960-62, about 1,670 units are planned for production, of which about 1,470 are for the SED [redacted] The drastic curtailment of production after 1962 implies that construction of the short 50X1

* Following p. 20.

** During 1963-65, only 300 units are planned for production.

Figure 12



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towers, and therefore of the expanded SED network, is scheduled for completion by the end of that year. A further analysis of figures on production leads to the conclusion that the 45 short and the 11 medium towers identified to date may be only a part of a larger construction program. On the assumption* that each of these facilities will contain four units, including a regular and a spare in each direction of transmission, production will be more than sufficient to equip a fixed tower in each of the 215 counties of the country. 22/

Investment in RVG-924 equipment is estimated to be about 38 million DME. This figure assumes that 950 of the 1,470 units produced for SED are for use in the short towers and will cost about 40,000 DME per unit. Initially, prototype RVG-924 equipment cost about 53,000 DME per unit, but it is expected that series production may reduce unit price.

Some short towers probably are for use for other than SED purposes. The towers in the vicinity of Zittau, Gera, Sonneberg, Saalfeld, and Suhl probably are for use as relay stations to close the southern ring of the microwave radio relay and television networks of the MPT. Other towers, such as those in the vicinity of Inselberg, Brocken, and Dresden, probably will serve to jam radiobroadcasts emanating from West Germany. [redacted] reception of Rundfunk im Amerikanischen Sektor (RIAS) Berlin was impaired after the short tower in the vicinity of Dresden was put into operation. 23/ 50X1

[redacted] 50X1

* Based on US experiences in equipping microwave radio relay sites.

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Until 1958, there was little use of coaxial cable in East Germany. Although the country had an extensive multiconductor cable network, as shown on the map, Figure 13,* coaxial cable facilities primarily consisted of the nearly completed "Ring Around Berlin." In addition to this ring, plans provided for the installation of about 3,000 km of coaxial cable, mainly around the perimeter of the country. Indication of the implementation of these plans came in late 1958 and early 1959, when a 245-km coaxial cable line was installed between East Berlin, Frankfurt an der Oder, and Cottbus. This line, called the Southern Trunk Carrier Cable, consisted of a twin 17a coaxial cable. 25/

It is significant that also in 1958 [redacted] the organizational structure of the Security Department of the MPT was changed. Control of this Department was transferred from the Main Administration for Telecommunications to the Second Deputy Minister of the MPT. Six specialized groups were established within the Department, of which one, known as SF1-NWA-Dienst (Air Raid Protection Service) reportedly was responsible for the construction and installation of an East German air defense network for use by the military. Another group, SF-2, was responsible for the installation of an air defense network for civil purposes. [redacted] East Germany planned to establish a telecommunications network to be used exclusively for early warning against air attack. Major facilities of this network were to consist of multiconductor and coaxial cable lines for telephone, telegraph, and video transmissions. The network, under control of the military, was to connect air warning headquarters located in each of the 14 districts of the country. Inasmuch as the investment plan of the MPT for 1959 included funds for the implementation of the project, it is assumed that this project is identical with the project associated with Air Raid Protection Service. The similarity of goals, as well as the involvement of the military in both projects, strengthens the creditability of this assumption. 26/

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Except for the installation of the line connecting East Berlin, Frankfurt an der Oder, and Cottbus, little progress apparently was made in the implementation of the project. In May 1959 the entire cable-laying program of the Air Raid Protection Service was dropped from the 1959 investment plan of the MPT. This change was necessitated by the limited facilities for production of coaxial cable in East Germany and by the heavy commitments for the export of high-capacity, multiconductor cable to other countries of the Soviet Bloc. The program is scheduled to be resumed in 1961 or 1962, at which time East Germany plans to import, from the West, automatic machinery for making coaxial cable. 27/

* Inside back cover.

The decision to delay a project which probably was intended to meet a high-priority military need strongly suggests that completion of other facilities to meet this need is imminent. The short towers, construction of which appears to have been accelerated, may be these other facilities. It is significant that the estimated completion date of the program for the construction of these towers approximates the estimated resumption date of the cable-laying program of the Air Raid Protection Service. The short towers possibly will be the primary facilities for the transmission of air defense information in East Germany, and the "hardened" communications facilities -- multiconductor and coaxial cable -- will be the secondary (backup) facilities. Although a system that utilizes dual facilities is necessarily costly, it could be indispensable in military air defense during war.

IV. Intra-Bloc Relationships

Masonry towers comparable to the tall towers under construction in East Germany also are under construction in Czechoslovakia, Poland, and the USSR. These towers also will be used for microwave radio relay communications and television broadcasting purposes. The photograph, Figure 14,* shows the masonry tower under construction at Velka Javorina in Czechoslovakia.** This tower is strikingly similar to the tall tower under construction at Roitzsch in East Germany, shown in the photograph, Figure 15.* 28/

To the extent that the construction of masonry towers in East Germany is related to that in other countries of the Soviet Bloc, this relationship probably reflects the influences of a Sino-Soviet Bloc organization formed in 1957, known as the Organization for Cooperation Among the Socialist Countries in the Fields of Post and Communications (OSS). This organization, which is under the domination of the USSR, has been concerned principally with standardizing, integrating, and expanding the telecommunications facilities and services of the Soviet Bloc. One of the major objectives of the OSS is to establish uniform microwave radio relay facilities in member countries for use in a Bloc-wide telecommunications (including television) network. Such a network*** would enhance the ability of the USSR to exercise control -- economic, political, and military -- over the other countries of the Bloc. Furthermore, it would add to the military capability of the Bloc as a whole because of the possible use of microwave radio relay facilities for transmitting air defense information.

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* Following p. 24.

** A similar tower is under construction at Petrin Hill near Prague.

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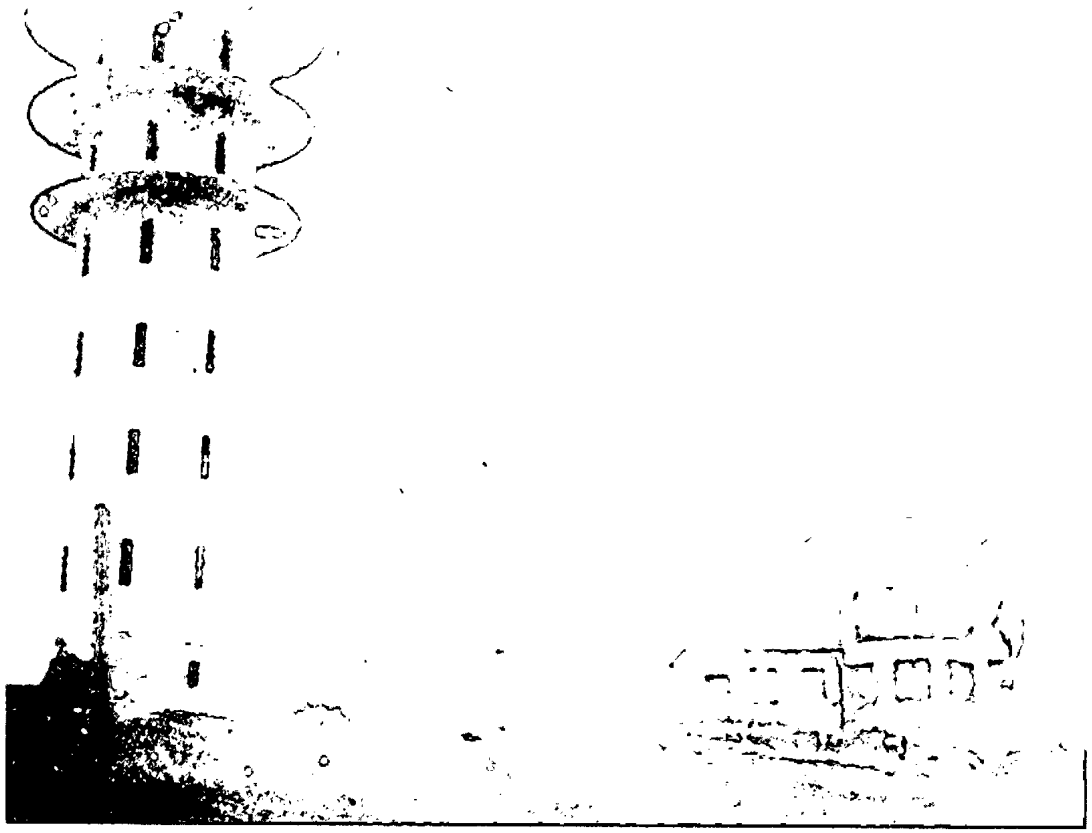

FIGURE 14
Czechoslovakia: Masonry Tower Under Construction at Velka Javorina, 1959

FIGURE 15
East Germany: Straight Category I (Tall) Tower Under Construction at Roitzsch, 1959

In an initial effort to attain these objectives, the OSS is believed to have developed plans for the construction of a microwave radio relay line connecting East Berlin, Warsaw, Prague, and Moscow. This line probably will be a modern, high-capacity facility capable of providing telephone, telegraph, and television services. The line will use either the East German RVG-958 or the Soviet Vesna microwave radio relay equipment. Inasmuch as the RVG-958 and the Vesna equipment are compatible, it is also possible that both types of equipment will be used.

A comparison of the locations of the masonry towers under construction or planned in East Germany and of those in other countries of the Soviet Bloc shows that the locations of some of the towers meet the requirements of the planned route. This is particularly true of the tall towers under construction and planned at Bernau/Birkholz and Dresden in East Germany and of the tower under construction at Petrin Hill in Czechoslovakia. It also is significant that these facilities are intended to utilize microwave radio relay equipment which is in accord with the plan. Information shows that the facilities in East Germany will use the RVG-958 equipment, whereas the facility in Czechoslovakia will use either the RVG-958 or the Vesna equipment, depending on the availability of each.

It is concluded that the program for the construction of tall towers in East Germany is related to an over-all program aimed at standardizing and integrating the telecommunications networks of the countries of the Soviet Bloc. The extensiveness of this relationship is not yet known. Neither is it known whether or not the other categories of towers under construction in East Germany are related to this over-all program. Nevertheless, to the extent that this relationship exists, the program in East Germany may foreshadow future developments in the other countries of the Bloc.

APPENDIX A

GLOSSARY OF TECHNICAL TERMS

Amplitude modulation (AM): The process by which a selected carrier frequency is varied in magnitude (amplitude) by other frequencies that contain the information to be transmitted in telecommunications. (See Frequency modulation.)

Apparatus: Instruments, machines, appliances, and other assemblies used in providing a telecommunications facility.

Automatic (as an adjective): Of or pertaining to any process involved in producing telecommunications service which does not require direct, immediate human assistance.

Band (of frequencies): The entire range of frequencies between two numerically specified frequency limits. The magnitude of this range is a limiting factor on the amount of information that can be transmitted in telecommunications. With respect to frequencies of the radio spectrum as a whole, the International Telecommunication Union has for convenience divided the whole radio spectrum into eight major bands, as follows:

Frequency Bands		
Range	Type	Corresponding Wave*
30 kc** and below	Very low frequencies (VLF)	Myriametric waves
30 to 300 kc	Low frequencies (LF)	Kilometric waves
300 to 3,000 kc	Medium frequencies (MF)	Hectometric waves
3,000 to 30,000 kc	High frequencies (HF)	Decametric waves
30,000 kc to 300 mc***	Very high frequencies (VHF)	Metric waves
300 to 3,000 mc	Ultra high frequencies (UHF)	Decimetric waves****
3,000 to 30,000 mc	Super high frequencies (SHF)	Centimetric waves****
30,000 to 300,000 mc	Extremely high frequencies (EHF)	Millimetric waves****

* Waves are undulating disturbances: a sound wave is a disturbance in the air, which is an elastic medium, and an electric wave is a disturbance in any medium whatever. The number of waves per second is the frequency of a given wave. Because the speed of wave propagation is considered to be constant, the length of a given wave is in inverse relation to its frequency: the longer the wave length, the lower the frequency, and the shorter the wave length, [footnotes continued on p. 36]

Cable: A bundle of sheathed, insulated wires and/or coaxial tubes, used as a telecommunications medium. It is sometimes referred to as "multiconductor cable."

Carrier (as an adjective): Of or pertaining to a technique for dividing a circuit, lane, supergroup, group, or channel into portions which can be used independently of and simultaneously with all other portions. Different frequencies or different pulses are selected for each portion to "carry" the information to be transmitted, after alternation by the information frequencies. The carrier itself need not be transmitted.

Channel: A portion, electrical or physical, of a telecommunications circuit, lane, supergroup, or group which can be used to transmit information independently of and simultaneously with all other portions. A channel may be used to provide two or more subchannels.

Circuit: A telecommunications connection between two or more distant points by a wire, cable, or radio medium facility used to carry information. The circuit is the fundamental telecommunications connection between distant points. By the application of appropriate techniques, a circuit may be arranged in many different combinations to meet the need for various kinds and quantities of telecommunications service. In its simplest form a circuit may carry only single telecommunications units in sequence. In its most complex form it may by apportionment carry sinultaneously thousands of telephone channels and telegraph subchannels; a number of television programs; and other specialized kinds of service, such as high-fidelity broadcast programs, radar signals, and data-processing signals.

For the most complex application, a circuit is often arranged into lanes, each of which can carry, in 1 direction, 1 television program or 600 telephone channels. In turn, these 600 telephone channels are subdivided into 10 supergroups of 60 telephone channels each. Each supergroup is subdivided into 5 groups of 12 telephone channels each. One or more telephone channels may be further subdivided into three to twenty 60-word-per-minute teletype subchannels. Other specialized kinds of service may be accommodated by combining two or more telephone channels.

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the higher the frequency. Wave length is usually measured in linear units of the metric system.

** Kilocycles per second, or 1,000 cycles per second.

*** Megacycles per second, or 1 million cycles per second.

**** It is becoming common usage to refer to waves (frequencies) in these three bands as "microwaves."

Coaxial (as an adjective): Of or pertaining to a modern telecommunications cable medium technique using one or more tubes (sometimes called "pipes"). Each metal tube surrounds a conducting wire supported concentrically by insulators. The space in the tube usually contains nitrogen gas under pressure. Generally, coaxial cable is used for the transmission of information in complex form, such as radar, computer data, or television signals, and/or for the transmission of telephone channels and telegraph subchannels. A single tube usually carries information in only one direction at a time. The capacity of a tube depends in part upon the distance between repeater stations. In the standard facility, which may have from 2 to 8 tubes in the cable, a single tube carries a lane of 600 telephone channels or 1 television lane, for which the repeater station spacing is about 7 statute miles. In a new developmental coaxial cable facility, a single tube may carry 3 lanes of a total of 1,800 telephone channels or 3 television lanes, for which the repeater station spacing is expected to be about 3 statute miles.

Electronics: A general term used to identify that branch of electrical science and technology that treats of the behavior of electrons in vacuums, gases, or solids. Today, telecommunications makes extensive use of electronic technology.

Facility: An association of apparatus, material, and electrical energy required to furnish telecommunications service.

Facsimile (as an adjective): Of or pertaining to a telecommunications (telegraph) service in which photographs, drawings, handwriting, and printed matter are transmitted for graphically recorded reception. In one method (Type A), images are built up of lines or dots of constant intensity. In another method (Type B), images are built up of lines or dots of varying intensity, sometimes referred to as "telephoto" and "photoradio."

Feeder (as an adjective): Of or pertaining to telecommunications facilities of relatively low capacity which join facilities of relatively high capacity. (See Main.)

Frequency: The rate in cycles per second at which an electric current, voltage, wave, or field alternates in amplitude and/or direction. (See Band.)

Frequency modulation (FM): The process by which a selected carrier frequency is varied in frequency by other frequencies that contain the information to be transmitted in telecommunications. (See Amplitude modulation.)

Functional (as an adjective): Of, pertaining to, or connected with special, unique, or particular telecommunications facilities managed and operated by a single agency, organization, company, department, committee, ministry, or other entity, in contrast to the facilities of a basic system.

Group: A number of channels (usually 12) or subchannels combined (multiplexed) electrically in building up the total capacity of a telecommunications circuit, lane, or supergroup.

Ionosphere: Those layers of the earth's atmosphere occupying the space about 210 statute miles in thickness extending from about 30 statute miles above the earth's surface to the outer reaches (exosphere) of the atmosphere. Reflection from these layers makes possible long-distance transmission of radio signals. The layers, however, are responsible for fading of signals, skip distance, and differences between daytime and nighttime radio reception. They are also used as a scattering reflector for ionosphere scatter-transmission techniques to transmit to distances of about 1,000 to 1,500 statute miles.

Joint facility: A telecommunications facility owned, controlled, or operated by two or more agencies, organizations, companies, departments, committees, ministries, or other entities.

Lane: A 1-way portion, electrical or physical, of a 2-way telecommunications circuit which can be used independently of and simultaneously with all other portions. The largest lane today can handle 600 telephone channels or 1 television program. In some applications the direction of a lane may be reversed.

Leased (as an adjective): Of or pertaining to the direct operation by a user of a telecommunications facility owned by another agency.

Line: A general term used to delineate a telecommunications circuit facility (wire, cable, or radio).

Main (as an adjective): Of or pertaining to telecommunications facilities at and between principal cities and centers which have relatively high capacity compared with feeder facilities. (See Feeder.)

Medium: Any substance or space that can be used practically to transmit a form of electrical energy for the purpose of providing telecommunications service.

Microwave radio relay (as an adjective): Of or pertaining to a radio medium technique in modern telecommunications employing radio

frequencies higher than 300 mc. These frequencies do not normally afford practical direct transmission to great distances, principally because they do not bend well around the earth's surface and because they do not reflect well from the ionosphere. They are, however, capable of reliable transmission from horizon to horizon (line-of-sight) by the use of special antennas which concentrate the radio energy and give it desired direction. Great distances can, in consequence, be reached by this technique by the interposition of relay stations along the route of the line with a spacing interval of from 25 to 40 statute miles, depending upon terrain conditions. This technique can be employed practically to carry from a small number of telephone channels and telegraph subchannels to thousands of such channels and subchannels through 2 or more lanes and to carry 1 or more television and other specialized lanes and channels. (See Band.)

Mobile (as an adjective): Of or pertaining to a telecommunications facility which is intended to be operational while in motion or during halts at unspecified points. (See Portable.)

Modulation: The process of altering a carrier frequency or carrier pulses by other frequencies or pulses representing the information being transmitted.

Multiplex (as an adjective): Of or pertaining to the combining of information signals, modulated or unmodulated, of two or more lanes, supergroups, groups, channels, or subchannels for transmission over the same circuit.

Network: An interconnection, electrical or physical, of two or more circuits or portions thereof for the purpose of facilitating telecommunications service.

Point-to-point (as an adjective): Generally, of or pertaining to telecommunications service between fixed points, using the radio medium.

Portable (as an adjective): Of or pertaining to a telecommunications facility which can be readily moved from place to place but is not normally operational while in motion. (See Mobile.)

Private (as an adjective): Belonging to or concerning an individual person, organization, institution, or activity; not public or common.

Pulse: A spurt of electrical energy of extremely short duration (usually measured in millionths of a second), yet capable of being used in telecommunications to transmit information.

Quad: In a multiconductor telecommunications cable, the physical association of a group of 4 conductors in any one of various arrangements for the purpose of providing 2-way multichannel operation.

Reception base: The aggregate telecommunications receiving facilities employed in providing a broadcast service.

Route: The geographical path followed by a wire, cable, or radio line.

Scatter (as an adjective): Of or pertaining to a radio medium technique in modern telecommunications by which energy in radio frequencies above 30 mc is deliberately scattered into one or the other of two reflecting portions of the atmosphere (troposphere and ionosphere) at a predetermined angle such that a usable portion of the energy arrives at the desired receiving location. This technique is especially applicable to regions in high latitudes (Arctic and Antarctic) where facilities of other media suffer from the rigors of weather and terrain and where the conventional long-distance radio media of the lower frequency bands (200 kc to 30 mc) are subject to serious disruptive propagational anomalies. (See Band.)

Subchannel: A portion, electrical or physical, of a telecommunications channel which can be used independently of and simultaneously with all other portions. An appreciable number of telephone channels can usually be subchanneled to carry from three to twenty 60-word-per-minute teletype subchannels on each telephone channel so employed.

Subscriber: Any customer who directly operates telecommunications apparatus in obtaining telecommunications service.

Supergroup: A number of groups (often five) combined (multiplexed) electrically in building up the total capacity of a telecommunications circuit or lane.

System: All of the facilities and networks managed by a single agency, organization, company, department, committee, ministry, or other entity in rendering either functional or basic telecommunications service.

Telecommunications: Transmission, reception, or exchange of information between distant points by electrical energy over a wire, cable, or radio medium facility to produce telephone, telegraph, facsimile, broadcast (aural and visual), and other similar services.

Teletype (as an adjective): Of or pertaining to a technique for effecting telegraph service by the use of an apparatus similar to a typewriter in which information is transmitted by keyboard and received by type printer on a roll of paper or a roll of tape, or by perforations on a roll of tape, or by both. (Sometimes called a "teleprinter" or "teletypewriter.")

Transmission base: The aggregate telecommunications transmitting facilities employed in providing broadcast service.

Transistor: A modern device which is capable of performing in a solid (germanium or silicon) many of the functions performed by the conventional electronic tube in a gas or vacuum.

Troposphere: The layer of the earth's atmosphere occupying the space from the earth's surface to a height of about 6 statute miles. This layer is used as a scattering reflector for tropospheric scatter transmission techniques to distances of about 200 to 500 statute miles.

Wave guide (as an adjective): Of or pertaining to a telecommunications medium, now under development in several countries, which may be capable of transmitting extremely large amounts of conventional and complex information. It consists of a circular or rectangular hollow metallic tube in which electrical energy travels in the form of waves, much as do sound waves in a speaking tube.

Wire diffusion: Distribution of broadcast programs by a wire or cable medium to wired loudspeakers.

Wired Loudspeaker: A telecommunications loudspeaker which receives from a distribution point one or more broadcast programs by a wire or cable medium.

Wireline: A general term used to identify a line consisting of either an aerial cable (and/or separate wires) or an underground cable, used as a telecommunications medium.

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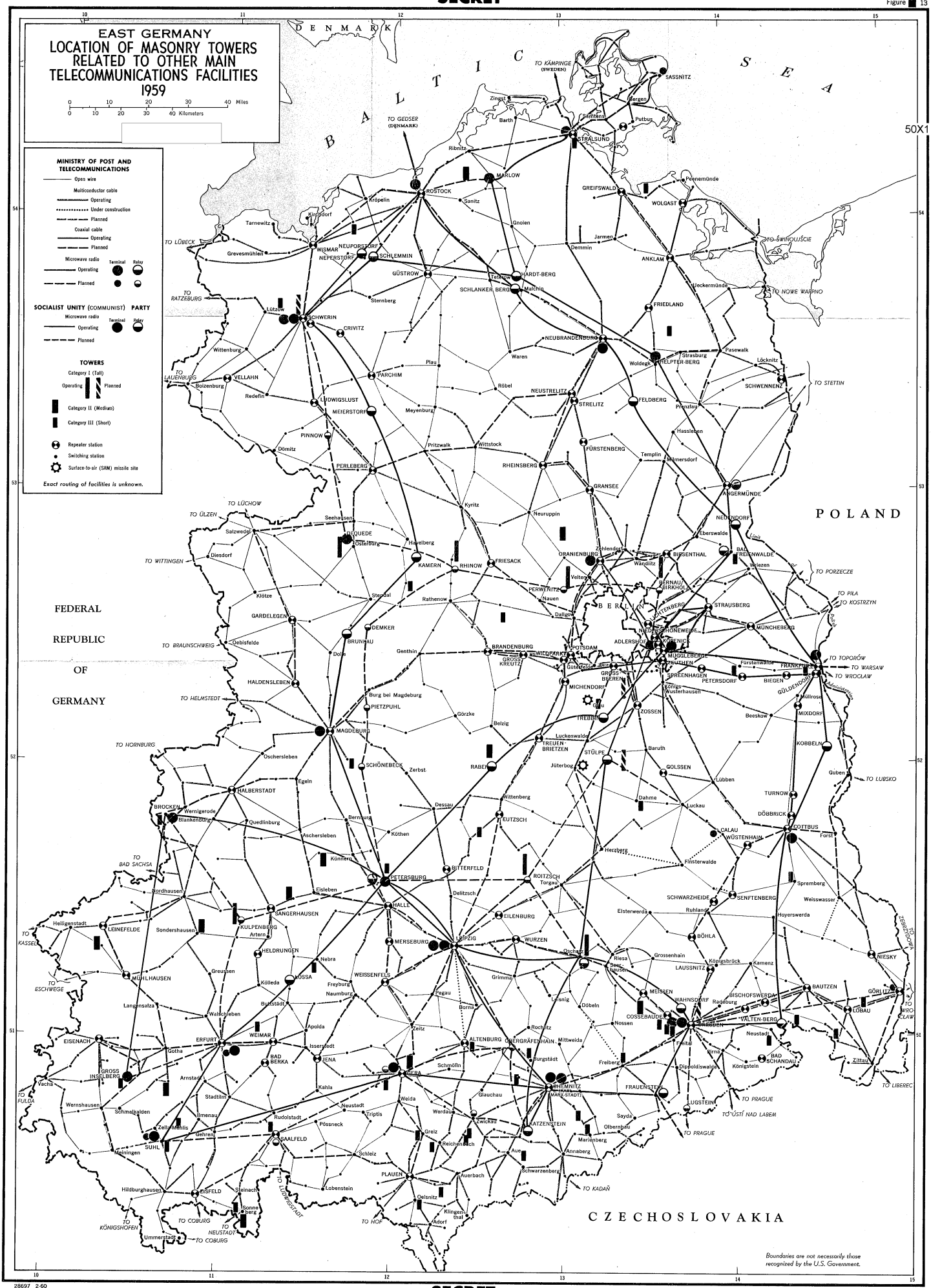
Figure 13



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